Summer of Innovation

Robotics Unplugged
4th – 9th grade

Introduction

The goal of the NASA Summer of Innovation Robotics Unplugged camp is to excite young minds and inspire student trainees toward future science, technology, engineering, and mathematics (STEM) pursuits. Raising student trainee achievement in STEM pursuits begins by leading students on a journey of understanding through these highly engaging activities. The activities and experiences in this guide come from across NASA's vast collection of educational materials.

This themed camp outline provides examples of one-day and two-day science and engineering programs. Each day contains 6-8 hours of activities totaling more than 12 hours of instructional time. The camp template will assist you in developing an appropriate learning progression focusing on the concepts necessary to engage in learning about rockets. The Robotics Unplugged camp provides an interactive set of learning experiences that center on the engineering design process and how we can envision, develop and build robots to help us in our work. The activities scaffold to include cooperative learning, problem solving, critical thinking, and hands-on experiences. As each activity progresses, the conceptual challenges increase, offering students full immersion in the topics.

Intended Learning Experiences

Through the participation in these camps future scientists and engineers will have the opportunity to explore robotics and have learning experiences that open the door and help make robotics something that they can envision in their lives, realize that they have the potential to make a contribution to this field and ignite their curiosity to see what they might create. The learning outcomes also anticipate that campers will be able to:

- Explain the roles of robots in our lives and at NASA
- Describe the role of the engineering design process in the development of a robot
- Demonstrate the role of journaling in engineering design
- Follow instructions and checklists in building
- Plan a design and follow through with a building plan
- Develop the communication skills that form the basis for programming
- Envision materials in a variety of new roles
- Discuss the mechanics of movement

Professional Development

Educator Professional Development (PD) experiences are available. Webinars, NASA Digital Learning Network (DLN) programs, training videos, and online meeting spaces will help you implement the program. We hope that you and your students have a memorable and successful experience implementing these activities.

Professional Development Resources

- The NASA Educator Online Network is a great resource for STEM educators to share and learn about STEM topics. The Robotics Unplugged camp hosts a group that will provide a place for sharing about the activities, additional resources, extension ideas, and support.
- Visit the Summer of Innovation homepage for an extensive catalog of news, media resources, and educational materials.
- NASA Robotics Website is a comprehensive collection of NASA resources that support robotics in educational settings.

Format of the Guide

The Six E's
Each day or section of activities utilizes the 5-E Instructional Model. Included in this program guide is a sixth 'E' for Excite. This additional 'E' shows you how to incorporate NASA's unique information and resources to excite students with career connections, real world examples, spinoffs from NASA research, and more. Learn more about the 5-E Instructional Model.

$ Requires simple materials common in the classroom or relatively inexpensive to obtain.

$$ Requires purchasing unique materials such as poster board, duct tape, or hot glue guns.

$$$ Requires purchasing or building higher-cost items, though many are one-time purchases that may used for many students over several years.

Title	Overview	Time	Cost	Additional Resources
The title hyperlinks to the activity.	An overview describes the main concepts and strategies used in the lesson, activity, or demonstration.	The time listed includes time for an introduction, activity time, and conclusion time.	Please find this camp or the activity you are using in the Resource Repository for more information on costs and tips.	Suggested resources may include additional lesson plans, posters, images, or other learning support materials.

Engage: Question?

Icons may appear throughout the program

A computer symbol means you may need one or more computers or other technology, though alternatives are available.

Journal

Journals are an optional element of your camp. Throughout the camp template, you will find reflective questions, ideas, and guidance in creating a journal. Journals also provide trainees with a unique souvenir of their experiences. Learn more about how scientists and engineers use journaling at NASA by watching this eClip video: Journaling in Space.

One - Day Program: Rover Construction

This one-day camp is designed to introduce some of the fundamental concepts of robotics and ignite a curiosity to discover more about robotics. Campers will become robotic specialists in training as they explore the role of robots in our lives and those that work at NASA. A delightful way to begin the day is welcome each new specialist with NASA identification (name tags) and assign them to a team of 2-4 specialists. Their goal today is to enter the training program and learn to build rovers. Once at their team's base, a pre-assigned table or area, they can begin to get to know each other and develop stories to *ID That Robot.* Participating in this activity helps students tie their previous knowledge of robots to questions that can help guide their activities for the day. This is followed by a traditional NASA activity: Mission Patch development. Each team will then delve into Rover Construction Techniques 101. An interactive webcast through NASA's Digital Learning Network (DLN) provides a briefing for the new specialists. After debriefing their initial construction, specialists will be introduced to the engineering design process as a development tool. Next, specialists will have the opportunity to extend their learning by refining their design and meeting a NASA Mission Challenge.

Title	Overview	Time	Cost	Additional Resources
Engage: Discover the Robots in our Lives and at work at NASA				
ID That Robot	Robotic specialists in training enter their NASA center and team base to find a stack of laminated robot pictures. Each team is responsible for guessing what these robots do at NASA and creating a story or guesses to go along with the picture. Encourage specialists to use as many descriptive words as possible. This is a great activity to have waiting for students as they arrive and are waiting for the whole team to assemble.	0.5 hrs	$	Following this link will take you to the Summer of Innovation lesson plans and background on using robotics. Scrolling down will connect you to a training module Robots at NASA that provides an overview of robotics. Sample pictures of robots at NASA
Mission Patches	As a team building activity each group may design a mission patch to represent them throughout the day. When each team has completed their patch they can introduce themselves to the group as a whole and choose one story/robot they are curious about to share with the whole group. Including the NASA e-Clips video can augment this section.	1.0 hrs	$ 	Follow this link to the NASA e-Clips website. If you enter Mission Patch into the search box it will connect to a great video you can use.
Explore: Rover Construction Techniques 101				

Rover Construction a.k.a Rocket Races	Specialists have the opportunity to work individually, getting help from teammates when need, to in their teams to build a balloon-powered rover. This is a great time to emphasize that robotics requires the ability to follow directions precisely in construction, mission parameters and communication. Rover Testing: You can make a research zone for the rovers to traverse on the floor with a 5x5 foot masking tape outline.	2.0 hrs	$	NASA eClips has a great example of a rover at work: just type Lunar Electric Rover into the search box
Explain: Briefing: Robotics at NASA				
Space Bots DLN Spacebots Lesson Overview	This is a NASA briefing for the new robotic specialists. Through the interactive DLN presentation Spacebots the specialists will be introduced to the many robots at work at NASA.	1.5 hrs	$ 	You can find informative videos about DLN here DLN registration page
Elaborate: Learning with the Engineering Design Process				
Debrief	Specialists return from their initial experience building a rover and discuss how it performed. This is a wonderful time to introduce the concept of the engineering design process	0.5 hrs	$	Two training modules on teaching engineering design can be found by following this link. Even at NASA there may be different versions of the design process in use. Visit the NASA BEST site to see more training videos
Evaluate: Summarize and Extend Knowledge About Robot Construction				
Briefing	Specialists can hear about the Desert-RATS (Desert Research and Technology Studies) team at NASA and how they are currently setting the goal of developing the equipment necessary to land on and explore an asteroid.	15 min	$ 	D-RATS Video Description of D-RATS asteroid goal
Rover Challenge	NASA Mission: Develop a prototype of a rover that can travel on rougher ground.	1.5 hrs	$	The Global Exploration Road Map provides a great visual

	Place a couple of obstacles in the research zone (this might be cardboard layers or wax paper or crumpled aluminum foil). Have specialists examine their first robot, get reconnaissance about the new landing zone. Next they can and take stock of the new parts they have available. Using the engineering design process have the team sketch a proposed robot. Next, the team builds a prototype and tests it on the new landing zone. Because not every student will have a model to take home educators can have the equipment to photograph the models and print out pictures for students.			summary of where we can explore in the universe. This activity is an extension of the Rocket Races lesson. To explore other ways to build rovers and other parts connect here to the Lunar Nautics Guide.
Debrief	Teams demonstrate their rover modifications and the results of the first test run. Teams conclude by listing their next steps in the design process and getting suggestions from the other teams.	15 min per team	$ 	Desert- RATS explains how they have modified ATHLETE in a NASA e-Clips on this webpage – Type 'Real World Triathlete' into the search box.
Excite: NASA Connection				
Virtual Mission and Test Site	Specialists can further their knowledge through simulations. At the D-Rats website they can log on at home or camp to attempt virtual data gathering and mission simulations.		$ 	To extend their learning students can try a virtual test site by Desert-RATS

Two-Day Program – Day One: Rover Construction

This two-day camp is designed to introduce some of the fundamental concepts of robotics and ignite a curiosity to discover more about robotics. On day one, campers will become robotic specialists in training as they explore the role of robots in our lives and

those that work at NASA. A delightful way to begin the day is welcome each new specialist with NASA identification (name tags) and assign them to a team of 2-4 specialists. Their goal today is to enter the training program and learn to build rovers. Once at their team's base, a pre-assigned table or area, they can begin to get to know each other and develop stories to *ID That Robot.* Participating in this activity helps students tie their previous knowledge of robots to questions that can help guide their activities for the day. This is followed by a traditional NASA activity: Mission Patch development. Each team will then delve into Rover Construction Techniques 101. An interactive webcast through NASA's Digital Learning Network (DLN) provides a briefing for the new specialists. After debriefing their initial construction, specialists will be introduced to the engineering design process as a development tool. Next, specialists will have the opportunity to extend their learning by refining their design and meeting a NASA Mission Challenge.

Title	Overview	Time	Cost	Additional Resources
Engage: Discover the Robots in our Lives and at work at NASA				
ID That Robot	Robotic specialists in training enter their NASA center and team base to find a stack of laminated robot pictures. Each team is responsible for guessing what these robots do at NASA and creating a story or guesses to go along with the picture. Encourage specialists to use as many descriptive words as possible. This is a great activity to have waiting for students as they arrive and are waiting for the whole team to assemble.	0.5 hrs	$	Following this link will take you to the Summer of Innovation lesson plans and background on using robotics. Scrolling down will connect you to a training module Robots at NASA that provides an overview of robotics. Sample pictures of robots at NASA
Mission Patches	As a team building activity each group may design a mission patch to represent them throughout the day. When each team has completed their patch they can introduce themselves to the group as a whole and choose one story/robot they are curious about to share with the whole group. Including the NASA e-Clips video can augment this lesson.	1.0 hrs	$ 	Follow this link to the NASA e-Clips website. If you enter Mission Patch into the search box it will connect to a great video you can use.
Explore: Rover Construction Techniques 101				
Rover Construction a.k.a Rocket Races	Specialists have the opportunity to work individually, getting help from teammates when need, to in their teams to build a balloon-powered rover. This is a great time to emphasize that robotics requires the ability to follow directions precisely in construction, mission parameters and communication.	2.0 hrs	$	NASA eClips has a great example of a rover at work: just type Lunar Electric Rover into the search box

	Rover Testing: You can make a research zone for the rovers to traverse on the floor with a 5x5 foot masking tape outline.			
Explain: Briefing: Robotics at NASA				
Space Bots DLN Spacebots Lesson Overview	This is a NASA briefing for the new robotic specialists. Through the interactive DLN presentation Spacebots the specialists will be introduced to the many robots at work at NASA.	1.5 hrs	$ 	You can find informative videos about DLN here DLN registration page
Elaborate: Learning with the Engineering Design Process				
Debrief	Specialists return from their initial experience building a rover and discuss how it performed. This is a wonderful time to introduce the concept of the engineering design process	0.5 hrs	$	Two training modules on teaching engineering design can be found by following this link. Even at NASA there may be different versions of the design process in use. Visit the NASA BEST site to see more training videos
Evaluate: Summarize and Extend Knowledge About Robot Construction				
Briefing	Specialists can hear about the Desert-RATS (Desert Research and Technology Studies) team at NASA and how they are currently setting the goal of developing the equipment necessary to land on and explore an asteroid.	15 min	$ 	D-RATS Video Description of D-RATS asteroid goal
Rover Challenge	NASA Mission: Develop a prototype of a rover that can travel on rougher ground. Place a couple of obstacles in the research zone (this might be cardboard layers or wax paper or crumpled aluminum foil). Have specialists examine their first robot, get reconnaissance about the new landing zone. Next they can and take stock of the new parts they have	1.5 hrs	$	The Global Exploration Road Map provides a great visual summary of where we can explore in the universe. This activity is an extension of the Rocket Races lesson. To

	available. Using the engineering design process have the team sketch a proposed robot. Next, the team builds a prototype and tests it on the new landing zone. Because not every student will have a model to take home educators can have the equipment to photograph the models and print out pictures for students.			explore other ways to build rovers and other parts connect here to the Lunar Nautics Guide.
Debrief	Teams demonstrate their rover modifications and the results of the first test run. Teams conclude by listing their next steps in the design process and getting suggestions from the other teams.	15 min per team	$ 	Desert- RATS explains how they have modified ATHLETE in a NASA e-Clips on this webpage – Type 'Real World Triathlete' into the search box.
Excite: NASA Connection				
Virtual Mission and Test Site	Specialists can further their knowledge through simulations. At the D-Rats website they can log on at home or camp to attempt virtual data gathering and mission simulations.		$ 	To extend their learning students can try a virtual test site by Desert-RATS

Two-Day Program – Day Two: Dexterous Robots

After completing Day 1 of their robotic specialist training, the specialists explore humanoid robots at NASA. Day 2 is spent learning about dexterous robots and the complex actions required to make hands work. First, each team explores the constraints and complexities of hands, tools, and protective gear. Next, specialists work on construction skills and anatomy as they construct a prototype of a hand. A debriefing reacquaints specialists with the engineering design process and its role in robotics construction. A briefing on sign language at NASA provides the knowledge needed to begin to tackle the dexterous hand building challenge. During the challenge, each team will design and build a prototype capable of signing a word in American Sign Language. The day concludes with the exciting video of Robonaut shaking hands with the Commander of the International Space Station and signing "Hello World."

Title	Overview	Time	Cost	Additional Resources
Engage: Constraints and Capabilities of Hands at Work in Space				
All Hands On Deck	Robotic trainees enter their NASA center and team base to find an assortment of gloves on the table. Each team will experiment with how the gloves change what work their hands can do. You might provide some Lego, Tinker toys, large wooden puzzles or pen and paper and assign each team a task to try while wearing various gloves.	0.5 hrs	$	
Helping Hands NASA eClips	NASA's Astronauts face a lot of challenges in space, including how to work with tools while wearing gloves and experiencing Newton's 3rd law while trying to work in space. You can share this eClips video with students to demonstrate these space obstacles and the innovative solutions we have found at NASA. Just type Real World Power Tools in Space into the search box on the eClips site.	0.5 hrs	$ 	Velcro is another great tool that helps NASA's astronauts keep tools accessible. From the Best Dressed Astronaut webpage you can show students this image of an astronaut's Velcro and tools.
Explore: Dextrous Robot Construction Techniques 101				
Robotics: Hands Down	Specialists have the opportunity to work individually, getting help from teammates when need, to in their teams to build a working model of a hand.	2.0 hrs	$	There is a training module called I want to Hold Your Hand that can be accessed by following this link. The module demonstrates how to build the hand.
Elaborate: Learning with the Engineering Design Process				

Debrief	Specialists return from their initial experience building a dexterous hand and discuss how it performed. This is a wonderful time to elaborate on the concept of the engineering design process	0.5 hrs		Two training modules on teaching engineering design can be found by following this link. Even at NASA there may be different versions of the design process in use. Visit the NASA BEST site to see more training videos
Evaluate: Summarize and Extend Knowledge About Robotic Hand Construction				
Briefing: What is Sign Language?	The International Space Station has had guests from all over the world, representing myriad languages. But until NASA astronaut Tracy Caldwell Dyson came aboard, one language was still not represented. Said to be the fourth most commonly used language in the United States, American Sign Language, or ASL, made its debut on the space station in a special video recorded by Caldwell Dyson. Robonaut is a humanoid robot and one of the newest residents on the International Space Station (ISS). Watch the video in the resources section to see how Robonaut uses its hands.	0.5 hrs	$ 	Video of Astronaut Caldwell Dyson is sending a sign language message The webpage Signs of Science explores sign language at NASA Video of the role Robonaut is expected to play on the ISS
Give me a Sign: Dexterous Hand Challenge	NASA Mission: Develop a prototype of hand that can sign a word. For example the hand sign for “I Love You” or a color such as yellow. Once specialists have chosen their word, they can return to the engineering design process and their first hand prototypes to determine what modifications are necessary to sign the word. You may want to encourage them to sign the word several times, each time observing their own hand and what parts move in what order. Next, they can and take stock of the new parts they have available.	1.5 hrs	$	Many guides to sign language are available on the internet or in the library. It may help for students to have access to various color rubber bands and string to help with color coding the patterns and directions they write to move the hand.

	Using the engineering design process have the team sketch a proposed new hand. Next, the team builds a prototype and tests it. Because not every student will have a model to take home educators can have the equipment to photograph the models and print out pictures for students.			
Debrief	Teams demonstrate their robotic hand modifications and the results of the first test run. Teams conclude by listing their next steps in the design process and getting suggestions from the other teams.	5-15 min per team		
Excite: NASA Connection				
Exciting News: Robonaut Signs!	An exciting new development at NASA is the arrival of Robonaut on the International Space Station (ISS). On February, 15th 2012 Robonaut shook hands with the Commander of the ISS and signed "Hello World."	15 min	$ 	Robonaut's debut video
Following Robonaut's Adventures	Specialists can continue to follow the adventures of NASA's dexterous robot. We look forward to many new challenges and the various ways Robonaut will lend a hand in space!		$ 	Robonaut's home page